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TECHNICAL MEMORANDUM

Utah Coal Regulatory Program

February 7, 2013

TO: Internal File

THRU: Daron Haddock, Coal Program Manager DRH
Ingrid Campbell, Mine Lead IC

FROM: Steve Christensen, Environmental Scientist SKC

RE: Division Order to Update the Probable Hydrologic Consequences, West Ridge Resources, Inc., West Ridge Mine, C/007/0041, DO-12A (Task ID #4247)

SUMMARY:

On January 11th, 2013 July 2nd, 2012, the Division of Oil, Gas and Mining (the Division) received an amendment to the West Ridge Mine's Mining and Reclamation Plan (MRP). The amendment was submitted by West Ridge Resources, Inc. (the Permittee) in response to Division Order DO-12A (the Division Order). The amendment was previously submitted and returned deficient (Task ID #4143).

The Division Order was issued to the Permittee on April 3rd, 2012 and required that the approved MRP be revised to address the potential impacts associated with groundwater interception within the underground mine works. The Permittee was directed to provide additional baseline data and describe potential impacts to surface and groundwater, water rights and the potential for post-mining discharges from the mine.

The issuance of the Division Order was primarily brought about by concerns raised by area water right holders/stakeholders at a June 23rd, 2011 meeting at the Division's Price Field Office. The concern was raised that mining activity within the Left Fork of Whitmore Canyon watershed had impacted their water rights resulting in flow reductions and subsequent loss of water reporting to the Grassy Trail Reservoir. It was the contention of the stakeholders, that the increase in mine water discharge was potentially the result of surface water and spring recharge areas being intercepted by mining activity. As the intercepted mine water is ultimately discharged to the C Canyon drainage, the stakeholders are concerned that their water rights are being interrupted from their natural flow path into Grassy Trail Reservoir.

The West Ridge Mine began to discharge during the 1st quarter of 2003. Prior to that time, mine water discharge did not occur during the first four years of operation. However; since early 2003, the mine water discharge has steadily increased from approximately 100 gallons per

minute (gpm) to 2,314 gpm in the 1st quarter of 2012. The average mine water discharge rate during that time period is approximately 712 gpm.

The Division Order required that the Permittee address the following items and make the requisite permit changes in accordance with R645-303-212, R645-303-220, R645-301-722 et seq., R645-301-724 et seq., and R645-301-728 et seq:

I. West Ridge Resources is required to provide additional baseline data that will characterize and describe the location and extent (areal and vertical) of the encountered mine-water discharge source area/recharge zone. At a minimum, the additional baseline data must also:
   a. Clearly identify/locate the source of the mine-water being intercepted by the mine.
   b. Provide an analysis of the chemical and physical properties of the intercepted mine-water (i.e. seasonal quality and quantity).
   c. Provide the approximate rates of discharge or usage for the intercepted mine-water.
   d. Provide additional geologic information, if it's determined that a fault system is the source of the intercepted groundwater (i.e. the fault properties and hydrologic pathways).

As required by R645-301-722, this baseline data characterization must also include cross-sections and maps.

II. West Ridge Resources is required to revise the PHC section of the MRP with supporting baseline data. The revision should provide a thorough discussion/examination of the potential impacts of groundwater interception within the mine works and its subsequent discharge into the C Canyon drainage. The revision must address (at a minimum):
   a. Whether adverse impacts may occur to the hydrologic balance as a result of the mine-water interception.
   b. Potential impacts to ground and surface water availability.
   c. Whether underground coal mining activity will proximately result in contamination, diminution or interruption of State-appropriated Water Rights.
   d. Discuss how State-appropriated Water Rights would be promptly replaced in the event that a water supply has been contaminated, diminished or interrupted by underground coal mining and reclamation activities.
   e. Discuss the potential for post-mining water discharges as well as the potential for associated water quality issues and potential treatment.

III. West Ridge Resources must provide additional isotopic analyses of the untreated mine-water discharge. In October of 2000, an isotopic analysis was performed on water discharging from a sandstone paleochannel located in the roof of the mine workings. As discussed in the MRP, the tritium content was very low. Additionally, the carbon-14 analysis suggested "*very old groundwater*." Due to uncertainties in the characterization of the carbon history of the water (relative to the carbon-13 composition), the Permittee indicated that the calculation of a groundwater "*age*" was not possible. An additional isotopic analysis would provide a beneficial comparison in evaluating the recharge source of the encountered mine-water.

The Division finds that the Permittee has addressed the provisions outlined in the Division Order DO-12A and that the revised PHC should be approved. The Division also finds that the hydrogeologic investigations conducted by the Permittee and the subsequent revisions to the West Ridge Mine PHC satisfy the commitment outlined on page 7-67 of the MRP. The commitment indicates that if the total cumulative flow from the underground flow meters located at long-wall panels #20 and #21 exceeds 250 gpm (approximately 0.5 cfs), a hydrogeologic investigation will be conducted and a subsequent revision of the PHC will be submitted. The latest data provided by the Permittee for underground flow-meters U-15E and U-17E (longwall panels #20 and #21 respectively), shows a cumulative flow average of 0.47 cfs since April of 2012. However; the cumulative flow from the two longwall panels has exceeded 0.5 cfs since July of 2012. As required by the commitment, additional hydrogeologic investigation work has been conducted and a subsequent revision to the PHC has been submitted by the Permittee. In both instances, the Permittee has satisfied this commitment.

TECHNICAL ANALYSIS:

ENVIRONMENTAL RESOURCE INFORMATION

Regulatory Reference: Pub. L 95-87 Sections 507(b), 508(a), and 516(b); 30 CFR 783., et. al.

HYDROLOGIC RESOURCE INFORMATION

Regulatory Reference: 30 CFR Sec. 701.5, 784.14; R645-100-200, -301-724.

Analysis:

Baseline Information

The amendment meets the Baseline Information requirements of the State of Utah R645-Coal Mining Rules and the requirements outlined in Division Order DO 12-A. As outlined previously, the Division Order directed the Permittee to provide additional information relative to:

a) Source/recharge areas for the mine-water being intercepted in the mine,
b) Chemical and physical properties of the intercepted mine-water,
c) Approximate rates of discharge or usage of the intercepted mine-water,
d) Additional geologic information if it's determined that a fault system is the source of the intercepted groundwater and
e) Additional isotopic analyses of the untreated mine-water discharge.

On page 7-38 of the amendment, the Permittee discusses the potential sources of groundwater currently encountered within the mine workings. The Permittee indicates that there are three generally observed pathways for groundwater to enter the mine:

1) Sandstone paleochannels in the roof,
2) Upwelling of groundwater from the floor and
3) Along fault and fracture damage zones.

The Permittee identifies these sources based upon observations of mine personnel with historical knowledge of the underground operations and the observations of Mr. Erik Petersen, Petersen Hydrologic, LLC. The Division has found that the three cited pathways of encountered groundwater are typical for coal operations in the Book Cliff's region. Difficulty arises in attempting to quantify the varying inflow contributions of each these sources.

Mine personnel have indicated that a significant amount of mine water is routinely intercepted from mined out gob areas. As longwall mining is completed in an area, safety considerations require that the areas be sealed, thus rendering them inaccessible. As a result, in many instances accurately identifying/locating a recharge area for a particular section of the mine is not possible as the water is collected in sump areas on the other side of the mine seal.

Geologic information presented in Appendix 7-1 identifies the mined coal seam as the Lower Sunnyside Coal Seam. It lies directly above the Sunnyside Sandstone Member of the Blackhawk Formation. The sandstone deposit above the coal seam is an unnamed member of the Blackhawk Formation. Based upon the information presented in Appendix 7-1, the Sunnyside Member of the Blackhawk Formation is relatively large (approximately 100 to 190 feet thick). Based upon the thickness of this formation, this sandstone layer is capable of potentially storing a large volume of groundwater.

On page 7-39 of Chapter 7 and page 10 of Appendix 7-17, the Permittee indicates that "*fault- and fracture-related groundwater inflows have been observed in the West Ridge Mine*". (See additional discussion regarding fault systems below)

Beginning on page 5 of Appendix 7-17, the Permittee presents an analysis of the solute geochemical properties of the encountered mine water as well as isotopic (age dating) analysis. During the fall of 2011 (October 10^{th} and 13^{th}), private consultant Erik Petersen, PG (Petersen Hydrologic) collected groundwater samples from four locations within the West Ridge Mine (a roof drip location, a floor seep location, a horizontal borehole as well as drainage from a longwall gob area). The locations of the sampling points are provided on Figure 1, *West Ridge Mine Workings and Groundwater Sampling Locations* in Appendix 7-17. Appendix 7-17 states, "*Sampling locations were selected in areas where representative water samples could be collected (many old mining areas are now sealed and inaccessible)*".

All four samples were analyzed for solute chemistry. Three of the four samples were also submitted for isotopic analysis (age dating). Appendix 7-17 provides additional isotopic data obtained from a sample collected in October of 2000 by Mayo and Associates. The 2000 sample was collected from a series of roof drips in the main entries located approximately 21 cross cuts in from the mine portals.

The solute/chemical compositions of the groundwater samples are presented in Table 1, *Chemical compositions of groundwaters sampled in the West Ridge Mine*. Figure 2, Stiff diagrams for West Mine groundwaters, provides the stiff diagrams derived from the 4 October 2011 samples.

Based upon the data presented by the Permittee, the water chemistry of the four October 2011 samples is quite variable. Stiff diagrams are commonly used analytical tools that depict the chemical compositions of ground and surface water samples. The roof drip sample and the floor seep sample had very different chemical compositions (sodium bicarbonate vs. magnesium sulfate chemical type). The two samples were collected in very close proximity to one another in the north-west portion of the mine (See Figure 1 of Appendix 7-17) yet produced very different chemical compositions. The sample collected from the sealed gob area in the north central section of the mine was of a sodium bicarbonate type composition. The horizontal borehole sample that was collected in a north-eastern section of the mine produced a sodium sulfate bicarbonate composition. The variability of the water chemistry at these sampling locations indicates that the recharge areas for these samples are not from the same source as the Permittee asserts (i.e. sandstone paleochannels in roof, upwelling of groundwater from the floor and along fault and fracture damage zones). If the recharge area for these underground sampling points was from the same recharge source, it's reasonable to expect that the solute chemistry would be similar.

Appendix 7-17 also provides isotopic analyses for the four October 2011 samples as well as from the sample collected in October 2000 by Mayo and Associates. Radiocarbon ages were calculated for three of the five water samples discussed in Appendix 7-17. According to the Permittee, "*a radiocarbon age could not be calculated for the 15^{th} West XC 32 Entry 2 Gob drainage sample or for the Main Dips Belt XC 21 sample due to uncertainties in the* *characterization of the carbon histories of these waters based on the positive carbon-13 compositions*". Tritium analysis was performed on all five samples.

Table 3, *Isotopic compositions of groundwaters sampled at the West Ridge Mine*, provides the measured tritium contents of all five water samples (i.e. the 2000 and the 2011 samples). Tritium is a naturally occurring radioactive isotope of hydrogen. It's naturally produced in our upper atmosphere and is subsequently incorporated into water molecules that enter the hydrologic cycle via rainfall and surface recharge to groundwater. The amount of tritium in the atmosphere increased as a result of above ground nuclear weapons testing in the 1950's. Thus, pre-bomb testing groundwater has significantly less tritium than recharge water entering the ground after the bomb testing began in the early 50's. It should be noted that tritium tests cannot be used to precisely calculate the age of water. Thus the tritium tests simply demonstrate whether water contains pre-1950 or post-1950 recharge.

The tritium concentrations obtained for each of the five samples was very low (See Table 3). Tritium (TU) concentrations less than 0.8 TU are indicative of submodern water (Motzer, William E., PhD, P.G., *Age Dating Groundwater*). The highest tritium concentration reported was obtained from the Panel 17 Horizontal Borehole location (See Table 3) with a tritium value of 0.20 TU. Based upon the tritium data, none of the five groundwater samples obtained from within the mine have been in contact with the surface since at least the early 1950's.

The radiocarbon tests were used to "*calculate the number of years that have elapsed since the groundwater became isolated from soil-zone gasses and near-surface groundwaters*". Table 4, *Radiocarbon "age" calculations for West Ridge Mine groundwaters*, provides the radiocarbon ages of the three samples that were analyzed. The age of the sampled groundwater ranges from 10,000 to 23,000 years (See Table 4). The radiocarbon results provide further evidence that suggests that the encountered mine-water has extremely limited connectivity with the overlying surface water and shallow groundwater systems.

On page 7-39 of the amendment, the Permittee addresses the approximate rates of usage of the encountered groundwater. The Permittee indicates that the typical amount of water utilized in the underground mining operation "*may amount to a few hundred gallons per minute*". The Permittee points out that a substantial amount of the water encountered underground is not consumed by mining activity (i.e. it is collected in sumps and ultimately discharged to the surface).

On page 4 of Appendix 7-17, the Permittee provides the flow rates obtained underground during the October 2011 hydrogeologic investigation performed by Mr. Erik Petersen (Petersen Hydrologic, LLC). The locations of the underground sampling locations are provided in Figure 1 of Appendix 7-17. The roof drip sample produced a low discharge rate of less than 1 gallon per minute (gpm). The floor seep sample produced a slightly large flow rate of approximately 1 gpm. The longwall gob drainage sample was collected from the gateroad entries adjacent to

Panel #17. The approximate rate of discharge was 250 gpm. The horizontal borehole sampling point was collected from a perforated 8-inch degasification pipe which the Permittee describes as extending approximately 3,000 feet laterally into the coal seam. According to the information presented in Appendix 7-17, the flow rate from the borehole's water trap was approximately 1 gpm.

Of the underground sampling points, the longwall gob drainage sample collected next to mined out Panel #17 produced the highest flow values (approximately 250 gpm) by far. According to mine personnel, a significant fault system was encountered in the area of Panels #16 and #17 that produced a significant inflow of water into the mine.

On page 7-36 of the amendment, the Permittee indicates that "*groundwater has previously been encountered in fault systems at the West Ridge Mine*". On page 7-39, the Permittee again notes that "*fault- and fracture-related groundwater inflows have been observed in the West Ridge Mine*". The Permittee discusses how it appears that the encountered fault systems are not in direct communication with the groundwater systems located near the surface (i.e. within the Colton and North Horn formations). The Permittee's assumption is based in part on the lack of tritium detected within the groundwater samples obtained in 2000 and 2011. The amendment discusses how it's likely that the encountered fault systems "*provide pathways of enhanced secondary porosity which interconnect the mine openings with nearby adjacent water-bearing strata*". Additionally, the Permittee indicates that "*the presence of hydrophyllic swelling clays in the rock strata likely limit the potential for fracture planes to remain open within these strata, particularly under the considerable confining pressures associated with the very thick overburden present at the West Ridge Mine.*" It's important to note that the Permittee is discussing the strata located directly adjacent to the mined coal seam and not the stratigraphic sections of bedrock located at the surface of the mine area (i.e. the Colton and North Horn Formations).

The previous technical analysis (Task ID #4143) identified deficiencies relative to the fault information presented in the amendment. Additional information was requested to verify the Permittee's assertion that the fault systems are not in direct connection with near surface groundwater systems and surface drainages. The Permittee was directed to provide additional information/discussion relative to the encountered fault systems within the West Ridge Mine and the resulting mine water inflows. Specifically, the Permittee was directed to provide further discussion as to whether or not the data presented in Appendix 7-17 is representative of the mine-water encountered from the fault systems identified by West Ridge mine personnel. A map was also requested that depicts the locations of the encountered fault systems within the mine and, if possible, collect additional solute and isotopic data from these systems.

In response, the Permittee provided a letter report, *Investigation of Fault Systems and Fault-Related Groundwater Systems at the West Ridge Mine* (See Appendix 7-18) prepared by Petersen Hydrologic, LLC (January 11th, 2013). The report outlines an investigation of a north-

northwesterly trending fault zone that has been encountered in several locations within the West Ridge Mine workings. The purpose of which was to evaluate the geologic characteristics and the groundwater systems associated with the north-northwesterly fault (the fault).

Plate 1, *Mapped Geologic Conditions* and Figure 1, *Fault-related groundwater sampling locations and north-northeast trending fault location at the West Ridge Mine workings* depicts the fault relative to the mine workings. Mr. Erik Petersen (Petersen Hydrologic, LLC) conducted a field visit to the West Ridge Mine on October 19th, 2012 to investigate the fault and to collect samples of groundwater for geochemical and isotopic analysis. The sample locations are shown on Figure 1 of the report. Table 1 provides the results from the solute chemical analyses. The isotopic results are provided in Table 2.

As part of the October, 2012 field investigation, Mr. Petersen collected samples from two previously sampled fault locations (Back Bleeder XC 60.5 Entry 1 roof Drip and Back Bleeder XC 60.5 Entry 2 floor seep). Chemical analysis was performed previously on these two points and discussed in Appendix 7-17. A new location (Mains XC 49 E4-E5) was sampled at the intersection of the fault and the main entries in the central portion of the West Ridge Mine (See Figure 1). At this location, groundwater was upwelling from fractures in the mine floor at a rate of 3.66 gpm. The tritium content of the sample was 0.40 TU, which is very low. The low tritium content is indicative of water that has not been exposed to the atmosphere since the 1950's. A radiocarbon analysis was also conducted; however, the results were not available at the time of the PHC revision submittal.

As discussed above, the two previously analyzed monitoring points (Back Bleeder XC 60.5 Entry 1 roof Drip and Back Bleeder XC 60.5 Entry 2 floor seep) were again sampled during the October 2012 field investigation by Mr. Petersen. The tritium content from both samples was very low (0.10 TU respectively), again indicative that the groundwater has been isolated from the surface for at least the past 50 years. The roof and floor seeps produced a very low flow (approximately 1 gpm).

Based on the isotopic analysis and the field observations of Mr. Petersen, it appears that the encountered fault system and generated groundwater is not in direct communication with the overlying surface and shallower groundwater systems and is not producing significant amounts of inflows into the mine.

Probable Hydrologic Consequences Determination

As outlined previously, the Division Order directed the Permittee to provide additional information relative to:

a) Whether adverse impacts may occur to the hydrologic balance as a result of the mine-water interception.

b) Potential impacts to ground and surface water availability.
c) Whether underground coal mining activity will proximately result in contamination, diminution or interruption of State-appropriated Water Rights.
d) Discuss how State-appropriated Water Rights would be promptly replaced in the event that a water supply has been contaminated, diminished or interrupted by underground coal mining and reclamation activities.
e) Discuss the potential for post-mining water discharges as well as the potential for associated water quality issues and potential treatment.

As the Book Cliff Mountains contain coal deposits of high economic value, they have been extensively drilled and analyzed. The physical and chemical characteristics of the overlying geology at the West Ridge Mine have been well established. Appendix 7-1 of the approved Mining and Reclamation Plan (MRP) provides a detailed discussion of the geology within the West Ridge Mine permit area. Figure 6, *Geologic cross-sections of bedrock formations in West Ridge study area* provides two cross-sectional views of the area geology. Figure 7, *Generalized stratigraphic section of bedrock in the study area*, provides an additional cross-section of the geology at the West Ridge Mine. Six bedrock formations are found within the permit area: the Mancos Shale, Blackhawk Formation, Castlegate Sandstone, Price River Formation, North Horn Formation and the Colton Formation. Numerous impermeable shale layers and swelling clays have been deposited between these strata that greatly reduce the potential for hydrologic communication between them (See Appendix 7-1). Due to the heterogeneity and relatively low permeabilities associated with overlying geology of the mine workings, the potential for vertical and horizontal flow of groundwater is limited.

Based upon previously submitted and approved baseline information within Appendix 7-1, the majority of springs within the West Ridge permit area discharge from the Colton and North Horn Formations (See page 59 of Appendix 7-1). The Colton and North Horn Formations comprise the cap rock of the West Ridge permit and adjacent area. Appendix 7-1 categorizes the Colton and North Horn springs as active groundwater systems. The information presented indicates that these "active" systems are located near surface exposures and are in direct communication with seasonal recharge (i.e. rainfall and snowmelt). Appendix 7-1 also identifies deep, "in-active" groundwater systems. The in-active groundwater systems are characterized in Appendix 7-1 as having very limited or no communication with annual recharge and produce minimal (if not non-detect) levels of tritium and radiocarbon dates between 500-20,000 years. The radiocarbon ages produced from the October 2011 underground sampling events produced an age range between 10,000 to 23,000 years (See Table 4 of Appendix 7-17) and extremely low tritium levels (See Table 3 of Appendix 7-17).

The Division finds that the potential for impacts to the hydrologic balance, ground and surface-water availability and State appropriated water rights is minimal. The basis for this finding is discussed below.

The Permittee discusses that the trace amount of tritium present in the water samples collected from the underground mine workings is evidence that the groundwater encountered in the mine is "*isolated from the shallow, tritium-rich active-zone groundwater systems that support most spring and seep discharges in the area*". As discussed above, none of the five groundwater samples obtained from within the mine have been in contact with the surface since at least the early 1950's. The absence of appreciable tritium levels within the underground mine water samples (See Appendix 7-17) is evidence of sub-modern water. If there was active communication between the overlying surface water systems and surface springs, it follows that the tritium levels would be considerably higher (i.e. indicative of a more modern water recharge area or modern component). Additionally, the radiocarbon ages of the three samples collected from the underground mine works in October 2011 ranged from approximately 10,000 to 23,000 years (See Table 4 of Appendix 7-17), providing further evidence that the in-active groundwater systems deep within the mine are not in direct communication with surface recharge. Mayo and Associates collected isotopic data from area springs and noted that most of the springs contained appreciable tritium concentrations and exhibited seasonal variability in discharge rates (See Appendix 7-1) thus providing additional evidence that the near surface springs within the Colton and North Horn formations are dependent upon seasonal recharge.

The thickness of overburden between the mined coal seam (Lower Sunnyside) and the overlying surface water systems and surface springs capable of providing baseflow to the Left Fork and Right Fork of Whitmore Canyon is massive. Overburden thicknesses within the Left and Right Forks of Whitmore Canyon range from approximately 1,000' to over 3,000'. The Mining Engineers Handbook recommends, that for full extraction mining below a water body with the potential for "*catastrophic damage*", a minimum vertical distance of 60 times the coal height be maintained. Coal seam data provided by the Permittee indicates that the maximum coal seam thickness within the Left Fork and Right Fork drainages of Whitmore Canyon is 8.0'; thus a conservative vertical distance to avoid impacts to overlying water bodies is 480'. Thus the potential for subsidence induced fracturing to encounter the surface drainages or near-surface springs (i.e. Colton and North Horn Formations) are considered minimal based upon the overburden thicknesses discussed previously.

Division staff has reviewed the most recent subsidence data submitted by the Permittee. In the operator's most recently submitted annual report (2011), no indications of subsidence damage were observed. Based on the data provided through aerial surveys and analysis, the amount of subsidence observed over West Ridge's panels that are mined without barriers between them is expected to be in the range of 0 to 4 feet on average, with the maximum being the mined seam thickness. The panels mined within the closest proximity to the Left Fork and Right Fork drainages were of the panel-barrier-panel configuration. Data indicates that subsidence observed over West Ridge's panels that are mined according to the "panel barrier panel" system is substantially less, being 0 to 2 feet on average. While subsidence data will occasionally include readings that are in error, the method West Ridge uses for monitoring is considered accurate. The overburden thickness above the panels mined is much greater than exists in other mines in Utah and the US and has contributed to West Ridge's lack of significant subsidence. The amount of subsidence that is reported by West Ridge annually is minimal and within expected ranges. Additionally, no surface subsidence indications have been reported/observed. Surface subsidence is expected to occur; however, fractures of the strata overlying the coal seam would not be expected to extend to the surface and intercept the shallow groundwater systems due to the extensive overburden in the area.

The historical flow measurements and current water monitoring data submitted to the Division on a quarterly basis have not produced evidence of a disruption or impact to surface and groundwater resources in terms of both quality and quantity as a result of mining activity. Evidence of seasonal variation of the mine water discharge rate is not evident (See Appendix 7-17, Figure 4, *Plot of discharge from the West Ridge Mine* (UPDES 002).

On page 5-31 of the approved MRP, the Permittee discusses water replacement/mitigation. The Permittee commits "*to mitigate the diminution or degradation of state appropriated waters within or adjacent to the permit area caused by surface affects of mine related subsidence. Mitigation measures would include such measures as sealing surface cracks with expansive clay materials (such as bentonite), trucking water, piping across fracture zones, transfer of water rights, installation of wildlife guzzlers and/or compensation to water rights owners*".

Beginning on page 7-45, the Permittee discusses the potential for a post-mining gravity discharge from the West Ridge Mine. The Permittee outlines several considerations that would indicate that the potential for a post-mining gravity discharge is minimal. The coal seam dip at the West Ridge Mine is fairly steep (13 degrees to the northeast). In order for groundwater to discharge from the mine portals (located at a higher elevation than the entire mine workings), the entire mine would need to fill with groundwater. The Permittee also cites the 2012 Petersen Hydrologic report provided in Appendix 7-17. Within that report, Mr. Petersen provides the isotopic data discussed above. As the water samples collected from within the mine workings produced a radiocarbon age range of 10,000 to 23,000 years and exceedingly low tritium values, Mr. Petersen argues that the groundwater intercepted in the mine is isolated from the surface and is "*being removed from storage in the deep, mountain-core area*". If the encountered groundwater within the mine were in contact with surface recharge zones, it follows that it would contain a modern component that would be evident by a presence of tritium. This is not the case. Additionally, based on the lack of homogenous rock formations overlying the West Ridge permit and adjacent area (See Appendix 7-1) and the low permeability of those rock strata, the potential for vertical and horizontal flow of groundwater is considered minimal. Thus, Mr. Petersen concludes that as a result of the geology, the "*potential for recharge to the groundwater systems from which old water has been drained from storage is low*". The Permittee further discusses that gravity discharge has not occurred at the adjacent Kaiser Steel Corporation Sunnyside Mine workings for 19 years since its closure. It's reasonable, based on the local geology that similar conditions would exist in the West Ridge Mine.

RECOMMENDATIONS:

The amendment should be approved at this time.

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